3.0 Selecting Calculation Method, WMU Type, and Modeling Pathway

3.1 Selecting Calculation Method

Each time you begin the program, select the mode of calculation. You can choose from two calculation methods: risk and allowable concentration. Click on the option button associated with either the risk calculation or the allowable concentration calculation mode. Each of these options is discussed below.

Risk Calculation Method

The first calculation method, risk calculation, allows you to develop inhalation risk estimates based on waste concentration levels that you specify. Results from the risk calculation method include (1) chemical-specific cancer risk estimates, (2) total cancer risk estimates (i.e., the summation of the chemical-specific risk estimates), and (3) noncancer risk estimates (i.e., HQs for noncarcinogens in the waste). Use the risk calculation option to develop risk estimates when you know the concentrations of the constituents in the waste. If the program results indicate that the waste poses an unacceptable risk to exposed individuals, then you should consider conducting a more site-specific analysis or implementing corrective measures to reduce the fraction of constituents released to the atmosphere. Such measures could include pretreatment of waste to reduce volatile chemical concentrations before the waste enters the unit or applying unit control technologies or practices to reduce volatile air emissions. Chapter 5 of the *Guide for Industrial Waste Management*, "Protecting Air Quality," identifies and discusses some emission control options.

Allowable Concentration Calculation Method

The second calculation method is an allowable concentration calculation that results in the development of waste concentrations (C_{waste}) that are protective of human health when managed as described. The calculation method can be applied in calculating waste concentrations for both wastewaters (C_{waste} in mg/L) and solid waste (C_{waste} in mg/kg). Concentrations are estimated based on user-defined target cancer and noncancer risk levels (e.g., 1E−5 for carcinogens, or an HQ of 1 for noncarcinogens), which you will set on a later screen, the RESULTS SCREEN. The program uses information gathered on the IWAIR screens to calculate for each chemical an allowable waste concentration that would not pose an inhalation risk to the receptor greater than the selected target level. You can use the allowable concentration calculation option to estimate waste concentrations for a WMU that has not yet received a waste, to determine what concentration(s) would pose an unacceptable risk to potentially exposed individuals.

3.2 Selecting WMU Type

Identify the WMUs that are used to manage wastes of concern at your facility and run the model separately for each WMU. Each of the four IWAIR unit types (described below) reflects waste management practices that are likely to occur at Industrial Subtitle D facilities.

Surface Impoundment. In the IWAIR tool, surface impoundments are considered to be ground-level, flowthrough units. The major source of volatile emissions associated with surface impoundments is the uncovered liquid surface exposed to the air (U.S. EPA, 1991). Impoundments can be quiescent (nonaerated) or aerated. Aeration or agitation is applied to aid in the treatment of the waste. Emissions tend to increase with an increase in surface turbulence because of enhanced mass transfer between the liquid and air (U.S. EPA, 1991). IWAIR can conduct emission modeling for both aerated and nonaerated surface impoundments. Parameters to which emissions are most sensitive include surface area, unit depth, waste concentration, retention time, wind speed for quiescent systems, and biodegradation.

The surface impoundment component of the IWAIR tool should not be used to model tanks. Although tanks have many common characteristics with surface impoundments with respect to volatile emissions, tanks are usually aboveground units, and height of the unit above the ground has a significant effect on dispersion factors. Therefore, the dispersion factors included in IWAIR for surface impoundments (which are presumed to be ground-level) are inappropriate for tanks and would produce erroneous results if so used.

Tilled Land Application Units. Wastes managed in land application units can be tilled or sprayed directly onto the soil and subsequently mixed with the soil by discing or tilling. Waste in a land application unit is a mixture of waste and soil. IWAIR allows the modeling of tilled land application units only. Spray application was not included because the degree of volatilization associated with this type of application practice is very site-specific and is influenced by a number of variables, including meteorological conditions and application equipment. Therefore, IWAIR is unsuitable for modeling spray land application units. Important characteristics for the tilled land application unit include surface area (the exposed area from which volatile emissions can be released) and the application rate (which affects the depth of the contamination, which, along with area, defines the extent of the source for volatile emissions).

Landfills. IWAIR allows modeling of emissions released from the surface of an active (i.e., receiving wastes) landfill. Volatilization can occur from the surface of the landfill. Important unit characteristics for the landfill include surface area and unit depth. IWAIR assumes that the landfill being modeled is a ground-level emission source.

Waste Piles. Waste piles are typically elevated sources used as temporary storage units for solid wastes. Important characteristics for the waste pile include surface area and height. These parameters define the exposed area from which volatile emissions can be released.

3.3 Determining Appropriate Modeling Pathway

Regardless of the calculation method selected (risk or allowable concentration), determine which modeling pathway to follow in using the tool. After deciding on the appropriate calculation method and modeling pathway, proceed to either Section 4 for detailed guidance on completing risk calculations or Section 5 for guidance on allowable waste calculations.

You can choose from four pathways that provide you with the flexibility of conducting modeling using IWAIR-generated emissions rates and dispersion factors, user-specified emission and dispersion estimates, or a combination of both IWAIR-generated and user-specified estimates:

- Pathway 1: Using CHEMDAT8 emission rates and ISCST3 default dispersion factors
- Pathway 2: Using CHEMDAT8 emission rates and user-specified dispersion factors
- Pathway 3: Using user-specified emission rates and ISCST3 default dispersion factors
- Pathway 4: Using user-specified emission rates and dispersion factors.

In selecting a pathway, consider the availability of site-specific information. For example, if you have access to a limited amount of site-specific data and do not have access to emissions measurement data, then you will likely want to follow either Pathway 1 or 2 to allow IWAIR to develop CHEMDAT8 emissions rates. Similarly, if you do not have the ability (i.e., resources or access to technical capabilities) to conduct site-specific air dispersion modeling, then you will want to follow either Pathway 1 or 3 to allow IWAIR to develop dispersion factors. If site-specific emission and dispersion rates are accessible or if resources are available to develop these data, Pathway 4 will provide the most refined site-specific results.

Additionally, consider model assumptions and capabilities. Because a number of assumptions are made by IWAIR in modeling emissions and dispersion, use of these features may not be appropriate in all cases. Review the following overviews of CHEMDAT8 emission modeling and ISCST3 default dispersion factors, as well as Section 1.4 on IWAIR's capabilities and limitations, prior to choosing a pathway.

Using CHEMDAT8 Emission Rates

EPA's CHEMDAT8 model has been incorporated into the IWAIR program to assist you in the development of chemical-specific emission rates. This model has undergone extensive review by both EPA and industry representatives and is publicly available from EPA's Web page (http://www.epa.gov/ttn/chief/software.html).

CHEMDAT8 considers many of the competing removal pathways that might limit air emissions, including adsorption and hydrolysis in surface impoundments and biodegradation in all types of units. Adsorption is the tendency of a chemical to attach or bind to the surface of particles in the waste and therefore to not volatilize into the air. Biodegradation is the tendency of a chemical to be broken down or decomposed into less-complex chemicals by organisms in the waste or soil; because this is a highly site-specific process, IWAIR allows you to choose whether to model biodegradation for all WMU types. Similarly, hydrolysis is the tendency of a chemical to be broken down or decomposed into less-complex chemicals by reaction with water. IWAIR does not model these breakdown products produced as a result of biodegradation or hydrolysis. Chemicals that decompose by either biodegradation or hydrolysis have lower potential for volatile emission to the air.

Loss of contaminant by leaching or runoff is not included in the CHEMDAT8 model. Both leaching and runoff are a function of a chemical's tendency to become soluble in water and follow the flow of water (e.g., due to rainfall) down through the soil to groundwater (leaching) or downhill to surface water (runoff). These two mechanisms would also result in less chemical being available for volatile emission to the air. CHEMDAT8 is considered to provide reasonable to slightly high (environmentally conservative) estimates of air emissions from the various emission sources. See the *IWAIR Technical Background Document* for a more detailed discussion of the emissions modeling.

IWAIR Assumptions Made for Modeling Volatile Emissions with CHEMDAT8

- Annual average temperature is determined by assigned meteorological station; user may override.
- Waste is homogeneous.

Quiescent and Aerated Surface Impoundment Assumptions:

- Flowthrough unit is operating at steady state.
- For aqueous-phase wastes, waste in the surface impoundment is well mixed.
- Organic-phase wastes are modeled under plug flow conditions.
- For aqueous-phase wastes, biodegradation rate is first order with respect to biomass concentrations.
- For aqueous-phase wastes, biodegradation rate follows Monod kinetics with respect to contaminant concentrations.
- For aqueous-phase wastes, hydrolysis rate is first order with respect to contaminant concentrations.
- For aqueous-phase wastes, biodegradation is modeled by default; user may turn off.

Tilled Land Application Unit Assumptions:

- The volume of the land application unit remains constant. As new waste is applied, an equal volume of waste/soil mixture becomes buried or otherwise removed from the active tilling depth.
- Biodegradation is modeled by default; user may turn off.
- For organic-phase wastes, biodegradation and hydrolysis are not modeled.

Landfill Assumptions:

- Only one cell is active at a time.
- The active cell is modeled as instantaneously filled at time $t = 0$ and open for the life of the landfill divided by the number of cells. Cells are either depleted of the constituent or capped at the end of this period.
- Biodegradation is not modeled by default; user may turn on.

Waste Pile Assumptions:

- Waste pile operates with fixed volume.
- Waste pile is modeled as a square box with essentially vertical sides.
- Biodegradation is not modeled by default; user may turn on.

Using ISCST3 Default Dispersion Factors

> **Assumptions Made for Dispersion Modeling**
>
> - An area source was modeled for all WMUs.
> - To minimize error due to site orientation, a square area source with sides parallel to *x*- and *y*-axes was modeled.
> - Modeling was conducted using a unit emission rate of 1 µg/m^2-s.
> - Receptor points were placed on 25, 50, 75, 150, 500, and 1,000 m receptor squares starting from the edge of the source, with 16 receptor points on each square.
> - Dry and wet depletion options were not activated in the dispersion modeling.
> - The rural option was used in the dispersion modeling because the types of WMUs being assessed are typically in nonurban areas.
> - Flat terrain was assumed.

The IWAIR default dispersion factors were developed by conducting air dispersion modeling with EPA's ISCST3 (U.S. EPA, 1995). This model is capable of modeling ground-level and elevated area sources. For IWAIR, landfills, land application units, and surface impoundments were modeled as ground-level area sources and waste piles were modeled as elevated area sources.

Because the ISCST3 model has considerable run times for area sources, modeling was conducted for a limited number of WMUs of representative sizes (i.e., surface areas, and heights for waste piles) using meteorological data obtained from 60 meteorological stations. The representative WMU sizes were selected from the range of sizes seen in the 1985 Screening Survey of Industrial Subtitle D Establishments (Shroeder et al., 1987). This database was the most comprehensive database that EPA had on waste unit characteristics. It contains data on 6,254 surface impoundments, 1,281 waste piles, 702 land application units, and 790 landfills. The IWAIR program is designed to cover the range of unit characteristics contained in the database. Specific areas to be modeled were selected from the skewed distribution of areas found in the Industrial D Survey database so that all WMUs in the database would be adequately represented and interpolation errors would be minimized. As a result, 17 surface areas were selected for modeling for the landfills, land application units, and surface impoundments. Eleven surface areas were selected for waste piles. In addition, 7 heights were selected to be modeled for waste piles, and waste piles were modeled at all possible combinations of the 11 areas and 7 heights.

> **Key Meteorological Data for the ISCST3 Model without Depletion**
>
> **Wind direction** determines the direction of the greatest impacts.
>
> **Wind speed** is inversely proportional to ground-level air concentration, so the lower the wind speed, the higher the concentration.
>
> **Stability class** influences rate of lateral and vertical diffusion. The more unstable the air, the lower the concentration.
>
> **Mixing height** determines the maximum height to which emissions can disperse vertically. The lower the mixing height, the higher the concentration.

The ISCST3 modeling was conducted with data obtained from 60 meteorological stations chosen to represent the various climatic and geographical regions of the contiguous 48 states, Hawaii, Puerto Rico, and parts of Alaska. The dispersion modeling was conducted using 5 years of data from each of the 60 meteorological stations. The meteorological data required as input to the ISCST3 model included hourly readings for the following parameters: wind direction, wind speed (m/s), ambient temperature (K), mixing height, and stability class.

Dispersion factors were obtained as output by running the model with a unit emission rate (i.e., 1 µg/m^2-s). The selected areas for each type of WMU were modeled using meteorological inputs obtained from the 60 representative meteorological locations. Receptors were placed in 16 directions at distances of 25, 50, 75, 150, 500, and 1,000 meters from the edge of the WMU. Figure 3-1 illustrates the pattern of receptor placement around the unit for a 10,000 m^2 unit; only receptors at 150 m or less are shown for clarity reasons. Receptor placement was made based on a sensitivity analysis that was conducted to determine the locations and spacings that would provide adequate resolution without modeling an excessive number of receptors. The resulting maximum annual average air concentrations at each distance serve as the IWAIR default dispersion factors.

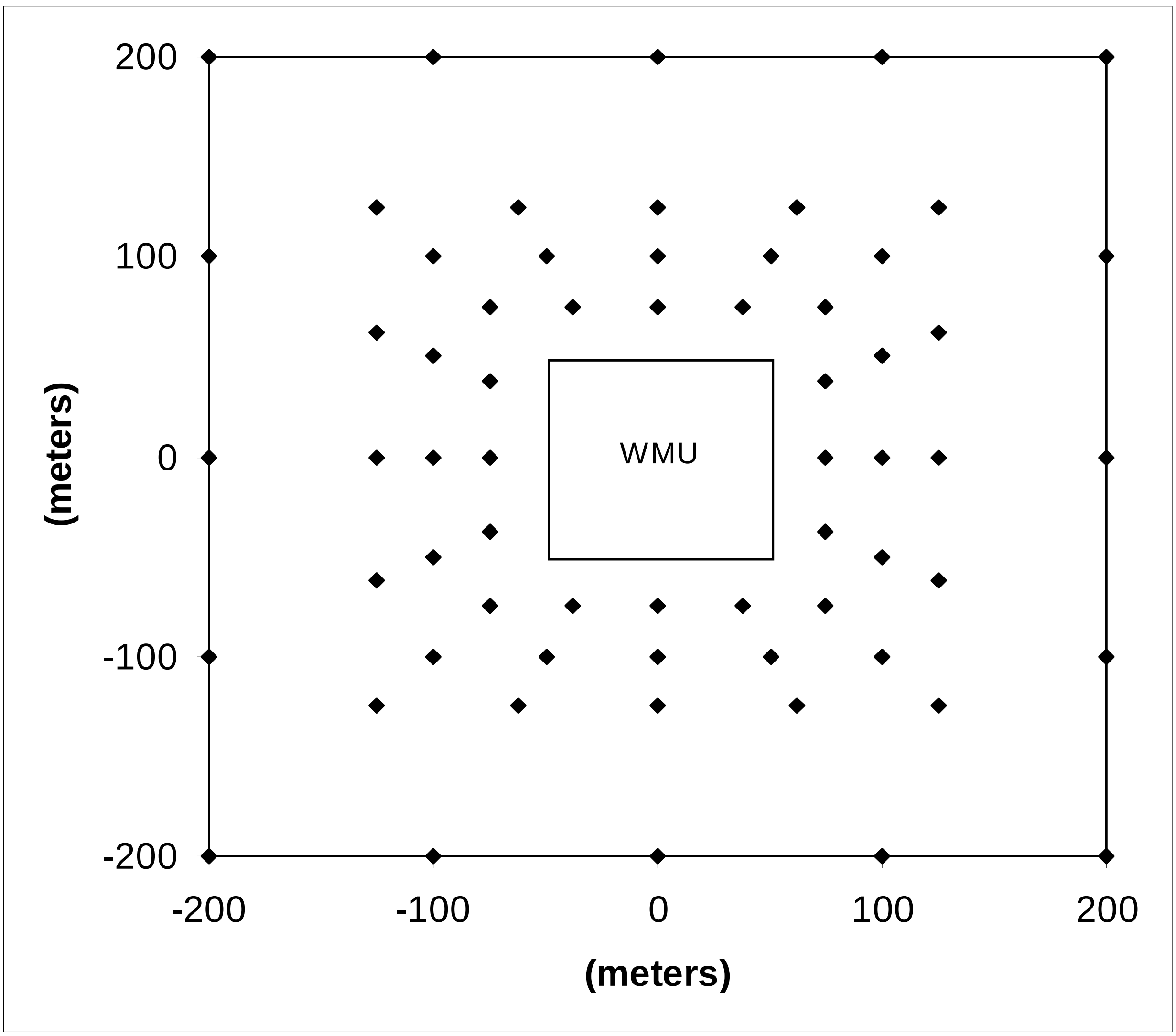

Figure 3-1. Receptor Locations.

Based on the WMU surface area (and height, for waste piles) that you provide, the IWAIR tool selects an appropriate dispersion factor. If the entered WMU surface area or height lies between two modeled areas or heights, dispersion factors for the WMU are estimated by an interpolation between dispersion factors for WMUs in the database with areas and heights above and below that of the WMU area you entered. For example, if you specify a landfill with a surface area of 8,000 m^2, the program will determine that this surface area falls between two modeled units with surface areas of 4,047 m^2 and 12,546 m^2. A linear interpolation method is then applied to estimate a dispersion factor for the 8,000 m^2 landfill, based on the default dispersion factors stored in the IWAIR database for two similarly sized units. For waste piles, a two-dimensional nonlinear interpolation method (called a spline) is used. See the *IWAIR Technical Background Document* for more information on the spline approach.